

Systematic Review

Pain Management Strategies After Abdominal Surgery: A Systematic Review of Anesthetic and Analgesic Interventions

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Abstract

Background: Effective perioperative pain management is important for recovery after abdominal surgery, reducing morbidity and improving patient outcomes. Thoracic epidural analgesia (TEA) have long been considered the gold standard. Newer regional anaesthesia and multimodal analgesic approaches are increasingly used to improve efficacy and safety. **Method:** This systematic review evaluated randomized controlled trials and clinical studies published between 2013 to 2025 focusing on anaesthetic and analgesic strategies for postoperative pain in adult patients undergoing abdominal surgery. Data regarding study design, patient population, interventions, and primary outcomes, including pain scores, opioid consumption, and recovery parameters, were synthesized. **Result:** Eleven eligible studies were identified. Evidence suggests that fascial plane blocks, transversus abdominis plane block, erector spinae plane block, and rectus sheath block provide comparable analgesia to TEA in selected populations, with fewer side effects. Adjunctive multimodal regimens, including intravenous agents, enhanced recovery pathways, and modified block techniques, showed further benefits in reducing opioid requirements and improving patient satisfaction. **Conclusion:** Fascial plane blocks and rectus sheath catheter analgesia, offer effective and safe alternatives to thoracic epidural analgesia for postoperative pain after abdominal surgery. When combined with multimodal regimens, these strategies reduce opioid consumption, improve recovery, and patient satisfaction. Individualized, block-based, and multimodal approaches should be considered to optimize perioperative pain management in abdominal surgery.

Keywords: Abdominal surgery; Postoperative pain; Analgesia; Regional anesthesia; Nerve blocks

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Introduction

Effective perioperative pain control is a cornerstone of recovery following abdominal surgery. Inadequate analgesia after major abdominal procedures is associated with impaired respiratory function, delayed mobilization, increased morbidity, and the risk of developing chronic postsurgical pain. Thoracic epidural analgesia (TEA) has been considered the gold standard for open abdominal surgery, owing to its ability to block both somatic and visceral nociception. Regional anesthesia techniques, abdominal wall and fascial plane blocks, have gained increasing attention. Early systematic evidence, including the Cochrane review by Charlton et al. [1], suggested that transversus abdominis plane (TAP) blocks reduced postoperative opioid requirements compared with placebo, though evidence was limited by small sample sizes. Subsequent meta-analyses confirmed that TAP blocks lower pain scores and reduce morphine consumption in abdominal procedures, although their efficacy relative to intrathecal morphine and epidural techniques is less certain. Alsamman et al. [2] evaluated TAP blocks in laparoscopic and robotic gynecological surgery, reporting modest or inconsistent benefits

The development of liposomal bupivacaine (LB) formulations offered the possibility of prolonged analgesia from a single injection. A Cochrane review by Hamilton et al. [3] show that surgical site infiltration of LB reduced postoperative pain compared to placebo, but showed no clear superiority to standard bupivacaine hydrochloride. Vereen et al. [4] focused on ultrasound-guided abdominal wall blocks with LB in open abdominal surgery. They concluded that while LB improved analgesia in cesarean sections with neuraxial anesthesia, evidence for other abdominal procedures was inconclusive. Nair et al. reported that TFPB was associated with reduced opioid consumption, delayed rescue

analgesia, and less postoperative nausea and vomiting, in cesarean sections [5]. This systematic review aimed to evaluate and synthesize evidence on anesthetic and analgesic strategies for postoperative pain management in adult patients undergoing abdominal surgery.

Methodology

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Fig 1). A literature search was performed in PubMed, Scopus, Web of Science, and the Cochrane Library, covering all publications available from 2013 to 2025. The search strategy include keywords and Medical Subject Headings (MeSH) related to postoperative pain, abdominal surgery, analgesia, epidural anesthesia, regional anesthesia, nerve blocks, and multimodal analgesia. The reference lists of retrieved studies were also screened to identify additional relevant articles.

The eligibility of studies determined according to predefined inclusion and exclusion criteria. Studies were considered eligible if they including adult patients aged 18 years or older undergoing abdominal surgery, either open or laparoscopic. Interventions of interest included any anesthetic or analgesic strategy for postoperative pain management, thoracic epidural analgesia, wound infiltration, regional nerve blocks, multimodal analgesic regimens, or non-pharmacological adjuncts. Only studies that reported outcomes, postoperative pain scores, opioid consumption, recovery parameters, or adverse events were included. Randomized controlled trials, clinical trials, and observational studies published in English were eligible. Exclusion criteria comprised pediatric studies, case reports, review articles, animal studies, and trials lacking relevant postoperative analgesia outcomes. The process of study selection involved two reviewers who screened all titles

and abstracts of retrieved records. Eligible articles were then assessed in full text to confirm their relevance to the review question. Disagreements during selection resolved by discussion, a third reviewer was consulted to reach consensus. Data from included studies were extracted using a standardized form, which captured key study characteristics, author details, year of publication, study design, sample size, study population, intervention and comparator, methods, outcomes, and main findings. A narrative synthesis was adopted to present and summarize the findings. Results were organized thematically according to the type of analgesic strategy, including epidural techniques, regional nerve blocks, multimodal approaches, and non-pharmacological interventions. The characteristic was consolidated in structured summary tables to facilitate comparison in studies and highlight emerging trends in postoperative pain management following abdominal surgery.

This study is a systematic review of previously published research and did not involve direct participation of human subjects or animals. Ethical approval and informed consent were not required.

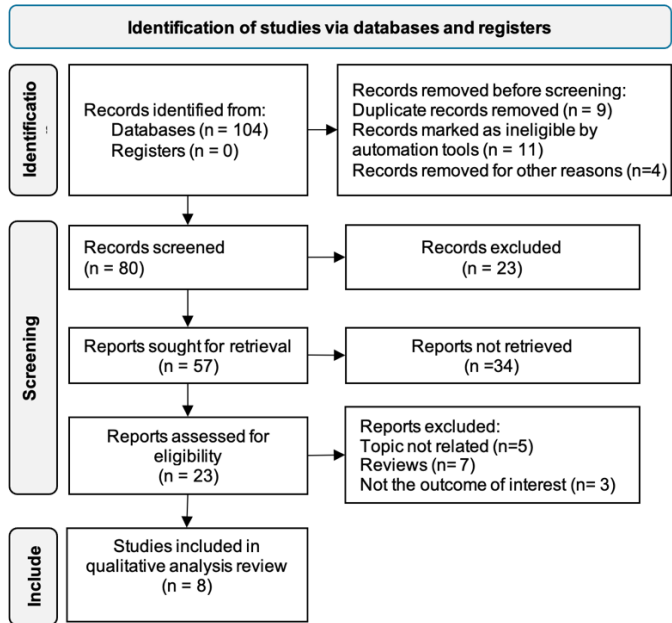


Fig 1: PRISMA consort chart

Results

Eight studies were included in this review (Table 1), randomized controlled trials, clinical trials, and one observational study. Sample ranging from 39 to 134 patients, with populations undergoing diverse abdominal surgical procedures including pancreatoduodenectomy, radical cystectomy, midline laparotomy, laparoscopic cholecystectomy, and gynecological laparotomy. Multiple studies compared regional blocks with thoracic epidural analgesia (TEA). Lee et al. [6] show that continuous wound infiltration (CWI) was non-inferior to TEA in postoperative pain scores on postoperative days (POD) 1–3, and TEA was associated with lower opioid consumption and higher rates of hypotension. Krige et al. [7] found that rectus sheath catheter analgesia (RSCA) provided comparable analgesia to TEA, with RSCA being superior at 72 hours due to fewer adverse effects and lower opioid requirements.

Korgvee et al. [8] reported no significant differences in opioid consumption between posterior quadratus lumborum block (QLB) and epidural analgesia, with both providing effective pain relief. Kusse et al. [9] found that erector spinae plane block (ESPB) reduced opioid consumption and delayed the time to first rescue analgesic compared with rectus sheath block (RSB), without complications. Avci et al. [10] show that the modified thoracoabdominal nerve block via perichondrial approach (M-TAPA) reduced pain scores and tramadol use in patients undergoing laparoscopic cholecystectomy.

Lai et al. [13] evaluated epidural combinations and reported that the four-drug regimen (morphine, ropivacaine, ketamine, naloxone) achieved the greatest reduction in analgesic consumption and better pain control compared to regimens with fewer agents. Ahmed et al. [11] found the effectiveness of multimodal strategies in major abdominal surgery, with epidural

analgesia at T8–T10 providing the highest satisfaction and pain relief. Lam et al. [12] investigated acupuncture-based interventions and reported modest improvements in

postoperative pain at 22 hours in the active treatment group (Table 2). The efficacy of this approach remained inconclusive compared to standard pharmacological methods.

Table 1: summary of studies

Citation	Study Design	Sample Size	Study Population	Method	Study Aim
Lee et al., 2024 (6) (Br J Surg)	Randomized, open-label, non-inferiority trial	134 (CWI 70, TEA 64)	Adults undergoing elective open pancreatoduodenectomy	CWI vs thoracic epidural analgesia; outcomes: pain scores POD1-3, opioid use, complications, recovery	Compare effectiveness of CWI vs TEA in postoperative pain management
Korgvee et al., 2022 (8) (Acta Anaesthesiol Scand)	Randomized controlled trial	39 (QLB 20, Epidural 19)	Adults (18–85) undergoing open radical cystectomy for bladder cancer	US-guided posterior QLB vs continuous epidural analgesia with ropivacaine	Compare opioid consumption and pain relief between QLB and epidural analgesia
Kusse et al., 2024 (9) (Anaesthesia)	Randomized controlled trial	72 (36 ESPB, 36 RSB)	Adults (18–65) undergoing midline abdominal surgery	US-guided erector spinae plane block vs rectus sheath block	Compare postoperative analgesic effectiveness of ESPB vs RSB
Ahmed et al., 2013 (11) (JOACP)	Prospective observational study	100	Adults undergoing elective major abdominal surgery	Epidural analgesia, PCIA, or opioid infusion; multimodal analgesia assessed	Evaluate strategies and effectiveness of postoperative analgesia
Lam et al., 2022 (12) (Phytomedicine)	Randomized, sham-controlled, patient- and assessor-blinded trial	72 (36 acupuncture, 36 sham)	Patients undergoing laparotomy for gynaecological diseases	Electroacupuncture + auricular acupuncture vs sham	Assess efficacy of combined acupuncture techniques for postoperative pain
Lai et al., 2016 (13) (Acta Anaesthesiol Taiwan)	Randomized, single-blinded trial	80 (4 groups of 20)	ASA I–II patients undergoing major upper abdominal surgery	Epidural combinations of morphine, ropivacaine, ketamine, naloxone	Investigate benefits of multimodal epidural regimens for postoperative pain
Krige et al., 2022 (7) (BJS Open)	Randomized clinical trial	131 (RSCA 66, TEA 65)	Adults undergoing elective open midline laparotomy (colorectal, urological surgery)	RSCA vs TEA; assessed pain scores, opioid use, functional recovery, morbidity, cost-effectiveness	Compare analgesic effectiveness and safety of RSCA vs TEA in major abdominal surgery
Avci et al., 2024 (10) (J Coll Physicians Surg Pak)	Randomized controlled trial	42 (21 M-TAPA, 21 control)	Patients undergoing laparoscopic cholecystectomy	Modified thoracoabdominal nerve block via perichondrial approach (M-TAPA) vs no block	Evaluate efficacy of M-TAPA for postoperative analgesia and opioid reduction

Table 2: demographics, analgesia used, findings and outcomes

Citation	Demographics	Anesthesia/Analgesia Used	Main Findings	Outcomes
Lee et al., 2024 (Br J Surg)	134 adults undergoing open pancreatoduodenectomy	CWI vs TEA	CWI non-inferior to TEA for pain scores POD1-3	CWI better recovery scores POD3; TEA lower opioid use but more hypotension
Korgvee et al., 2022 (Acta Anaesthesiol Scand)	39 adults (18–85) with bladder cancer, open radical cystectomy	Posterior QLB vs Epidural (ropivacaine)	No significant difference in opioid consumption POD0-2	Both techniques provided similar pain relief
Kusse et al., 2024 (Anaesthesia)	72 adults (18–65) undergoing midline abdominal surgery	ESPB vs RSB	ESPB reduced opioid consumption and prolonged time to first analgesic request	No complications; ESPB more effective overall
Ahmed et al., 2013 (JOACP)	100 adults, elective major abdominal surgery	Epidural, PCIA, IV opioid infusion	Multimodal analgesia widely used, high satisfaction	Epidural at T8–T10 provided best pain relief; overall satisfaction high
Lam et al., 2022 (Phytomedicine)	72 women undergoing laparotomy for gynaecological diseases	Electroacupuncture + auricular acupuncture vs sham	Acupuncture group had lower pain at 22 hrs	Safe and feasible but inconclusive efficacy
Lai et al., 2016 (Acta Anaesthesiol Taiwan)	80 ASA I–II adults, upper abdominal surgery	Epidural M+R, M+R+K, M+R+N, M+R+K+N	M+R+K+N reduced analgesic consumption significantly	Better pain scores and outcomes with 4-drug combo
Krige et al., 2022 (BJS Open)	131 adults (colorectal, urological surgery, open midline laparotomy)	RSCA vs TEA	TEA superior at 24h, RSCA better by 72h	RSCA fewer side effects, lower opioid use day 3, cost-effective
Avci et al., 2024 (JCPSP)	42 adults, laparoscopic cholecystectomy	M-TAPA vs control	M-TAPA lowered VAS/NRS scores and reduced tramadol use	Effective for up to 24h, reduced opioid consumption

ASA-American Society of Anesthesiologists; CWI-Continuous Wound Infiltration; ERAS-Enhanced Recovery After Surgery; ESPB=Erector Spinae Plane Block; LB-Liposomal Bupivacaine; M-TAPA- Modified Thoracoabdominal Nerve Block via Perichondrial Approach; NRS-Numerical Rating Scale; PCIA-Patient-Controlled Intravenous Analgesia; POD-Postoperative Day; QLB-Quadratus Lumborum Block; RSB-Rectus Sheath Block; RSCA-Rectus Sheath Catheter Analgesia; TEA-Thoracic Epidural Analgesia; TAP-Transversus Abdominis Plane Block; TFPB-Transversalis Fascia Plane Block; VAS- Visual Analogue Scale; M+R-Morphine + Ropivacaine; M+R+K-Morphine+ Ropivacaine +Ketamine; M+R+N-Morphine + Ropivacaine + Naloxone; M+R+K+N; Morphine + Ropivacaine + Ketamine + Naloxone

Discussion

This systematic review includes eight studies examined different analgesic strategies after abdominal surgery, including thoracic epidural

analgesia (TEA), regional nerve blocks, multimodal epidural regimens, and non-pharmacological interventions. The results show that regional anesthesia techniques, continuous

wound infiltration (CWI), rectus sheath catheter analgesia (RSCA), erector spinae plane block (ESPB), and modified thoracoabdominal nerve block via perichondrial approach (M-TAPA) provided effective postoperative analgesia, reduced opioid consumption, and associated with fewer adverse effects compared with TEA in several contexts.

Earlier systematic reviews highlighted the analgesic potential of transversus abdominis plane (TAP) blocks and related abdominal wall techniques. The Cochrane review by Charlton et al. [1] found that TAP blocks reduced postoperative morphine requirements at 24 and 48 hours compared with placebo, though evidence was limited and heterogeneity was present. More recent meta-analyses reinforced these findings. Brogi et al. [14] reported that TAP blocks lowered visual analogue scale (VAS) pain scores at 6–24 hours and reduced 24-hour morphine consumption by approximately 15 mg, confirming their opioid-sparing effect across multiple abdominal procedures. Nair et al. [5] show that transversalis fascia plane blocks, another abdominal wall block, were effective in reducing opioid use, delaying rescue analgesia, and decreasing postoperative nausea and vomiting, further supporting the role of fascial plane blocks in multimodal pain strategies. These results resonate with our review, in which ESPB and M-TAPA also showed opioid-sparing benefits compared with control groups or alternative blocks.

The use of liposomal bupivacaine (LB) in abdominal wall blocks generated particular interest. The systematic review by Vereen et al. [4] concluded that ultrasound-guided abdominal wall blocks with LB reduce opioid consumption, in cesarean section populations, though evidence in open abdominal surgery is inconclusive. A Cochrane review by Hamilton et al. [3] found that LB infiltration at the surgical site reduced postoperative pain compared with

placebo but was not superior to conventional bupivacaine. These findings underscore that LB offer extended analgesia, but its advantages over standard local anesthetics is uncertain. Our review did not directly evaluate LB but corroborates that regional techniques without epidural analgesia provide a good pain relief. According to Krige et al., [7] where RSCA was comparable to TEA and show advantages in terms of fewer side effects and cost-effectiveness at 72 hours. Accumulating evidence indicates that abdominal wall catheter techniques substitute TEA in enhanced recovery pathways, especially in patients at risk for epidural-related adverse events, hypotension or urinary retention.

Alsamman et al. [2] found that TAP blocks provided no difference in 24-hour pain scores compared to no block or local infiltration, with evidence graded as very low to low certainty. This contrasts with our findings, where ESPB and M-TAPA produced clinically better reductions in pain and opioid consumption in laparoscopic and open abdominal settings. The discrepancy reflect heterogeneity in block technique, anesthetic agents, and surgical populations.

Conclusion

Regional anesthesia techniques [CWI, RSCA, ESPB, and M-TAPA) provided effective postoperative analgesia with reduced opioid requirements and fewer side effects compared to TEA in some contexts. Multimodal epidural regimens improve analgesic efficacy, and acupuncture demonstrated potential but requires further evidence. The findings indicate that individualized analgesic strategies, incorporating regional techniques or multimodal regimens, optimize postoperative pain outcomes in abdominal surgery.

Ethical Approval Statement

This systematic review did not involve human or animal subjects. Ethical approval was not required.

Conflict of Interest

The authors declare no conflicts of interest.

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Data Availability

All data generated or analyzed during this study are included in this published article.

Authors' Contributions

All authors meet the ICMJE criteria for authorship, contributed significantly to this work, and approved the final manuscript.

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